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Original Article

Impact of Scan Body Design on Accuracy and Reliability of Implant Impressions with Intraoral Scanners: A Systematic Analysis

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ABSTRACT

Precise implant impressions are essential for accurately reproducing the three-dimensional (3D) orientation of implants. Digital protocols using intraoral scanners (IOSs) and scan bodies provide significant benefits over traditional elastomeric approaches. Nevertheless, the geometry of scan bodies can influence the accuracy and fidelity of IOS-derived data, and the ideal design parameters are not yet established. This systematic review aims to analyze how variations in scan body geometry affect the trueness of digital implant impressions captured via IOSs. Comprehensive searches were performed in PubMed, Scopus, EMBASE, Web of Science, Cochrane Library, and Google Scholar databases up to 25 February 2025. Studies examining the relationship between scan body geometry and the accuracy of implant-level digital impressions using IOSs were included. Methodological quality was evaluated using the Quality Assessment Tool for In Vitro Studies of Dental Materials (QUIN). Twenty-eight studies met inclusion criteria, including twenty-six in vitro investigations. The publications, dated from 2020 to 2025, revealed that both macro- and micro-geometry variations influenced linear and angular accuracy. Cylindrical configurations with appropriate proportions typically demonstrated superior outcomes compared to cuboidal or spherical shapes. Design alterations, such as reinforced bar extensions or faceted surfaces, frequently enhanced scan precision. Some hybrid or modified geometries performed similarly to standard scan bodies. Based on QUIN assessment, twenty-seven studies were of moderate quality, and one was rated as high quality. The geometry of scan bodies significantly affects the accuracy of intraoral digital implant impressions. Simplified or reinforced structural forms tend to improve both trueness and reproducibility. Additional standardized clinical trials are required to identify ideal geometric features and to corroborate existing in vitro evidence.

Keywords: Dental implants, Intraoral scanners, Scan body geometry, Digital impressions, Accuracy, Trueness, Systematic review

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Introduction

Precise transfer of implant location is critical for the long-term performance of implant-supported restorations [1]. Conventional impression methods depend on copings and elastomeric substances [2], whereas the introduction of intraoral scanners (IOSs) has facilitated faster, fully digital workflows. These digital approaches shorten clinical procedures, enhance patient comfort, and remove the necessity for physical casts [3]. Evidence indicates that digital implant impressions can achieve accuracy levels comparable to those obtained with traditional techniques [4–6].

Within the digital workflow, the scan body functions as a key reference for determining implant positions [7]. Traditional methods are often affected by deformation, polymer contraction, and operator sensitivity [8], while IOS-based approaches using scan bodies enable consistent, high-resolution impressions with reduced discomfort [8–10]. Consequently, IOSs have become increasingly integrated into clinical dentistry [10].

Scan bodies vary in dimensions, contours, surface details, and base materials—all factors that can influence scanning reliability [9]. Many designs feature anti-rotational elements like beveled edges or flat planes that align with implant interfaces, yet the optimal structure of these components is still uncertain [11, 12]. Furthermore, debates continue over whether metallic or polymeric compositions, and various surface finishes, yield higher scanning accuracy [9].

The performance of IOSs is commonly analyzed in terms of precision (repeatability) and trueness (closeness to the true reference) [13, 14]. Although several systematic reviews have discussed the general accuracy of IOS systems [1, 4, 14, 15], only a few have specifically assessed how scan body geometry impacts outcomes. Current meta-analyses have not reached agreement on ideal structural parameters such as geometry, size, and surface features [16, 17]. Given the expanding role of digital impressions and the increasing range of scan body designs, a focused systematic review is warranted. This review thus investigates how scan body geometry—including macrostructure, micro-features, and supporting elements—affects the accuracy of IOS-based implant impressions, aiming to provide clinicians with evidence-based guidance for optimal scan body selection and improved clinical precision.

Materials and Methods

Review design and protocol

This review followed the PRISMA 2020 statement for systematic reviews and meta-analyses [18]. It was not preregistered in any database. The research question was structured using the PICO model, where:

P (Population): implant-supported restorations,
I (Intervention): intraoral scanning using scan bodies,
C (Comparison): various scan body configurations,
O (Outcome): the fidelity and accuracy of the obtained digital implant impressions.

To maximize search breadth and sensitivity, outcome-related keywords (e.g., precision, accuracy, trueness) were excluded from the query. This decision, consistent with previous evidence-based frameworks and expert suggestions, ensured that no potentially relevant research was overlooked, even if alternate metrics or terminologies were used in the original reports.

Eligibility criteria

Study types

Eligible papers included peer-reviewed in vitro and in vivo research, as well as randomized or non-randomized trials, cohort, and case–control designs. Excluded were duplicate publications, conference papers lacking full text, and studies omitting details about scan body geometry. No filters were applied regarding publication year, language, or participant demographics.

Participants

Included studies involved intraoral scanning of dental implants using scan bodies. Both clinical and laboratory models (including typodont or patient-based setups) assessing how design variables affected the precision of impressions were considered.

Interventions and comparisons

The primary intervention consisted of digital impression procedures performed with IOSs in combination with scan bodies. The comparative analyses addressed different geometric features, such as shape variations (cylindrical, conical, or hexagonal), size, surface alterations, and structural enhancements.

Outcomes

The main variable of interest was trueness, defined as the degree of deviation between the actual implant location and the digitally recorded position. Any study employing validated analytical methods for measuring trueness was eligible for inclusion.

Information sources and search strategy

The literature search encompassed PubMed/MEDLINE, Scopus, EMBASE, Web of Science, and the Cochrane Library, finalized on 25 February 2025. A combination of controlled vocabulary (MeSH) and free-text terms related to scan body configuration, digital impression accuracy, and intraoral scanning were applied **(Table S1)**. Manual screening of reference lists from all relevant publications and reviews was also conducted. In addition, the first 300 Google Scholar records were reviewed to capture any gray literature [19]. The selection process is illustrated in the PRISMA flow diagram **(Figure 1)**.

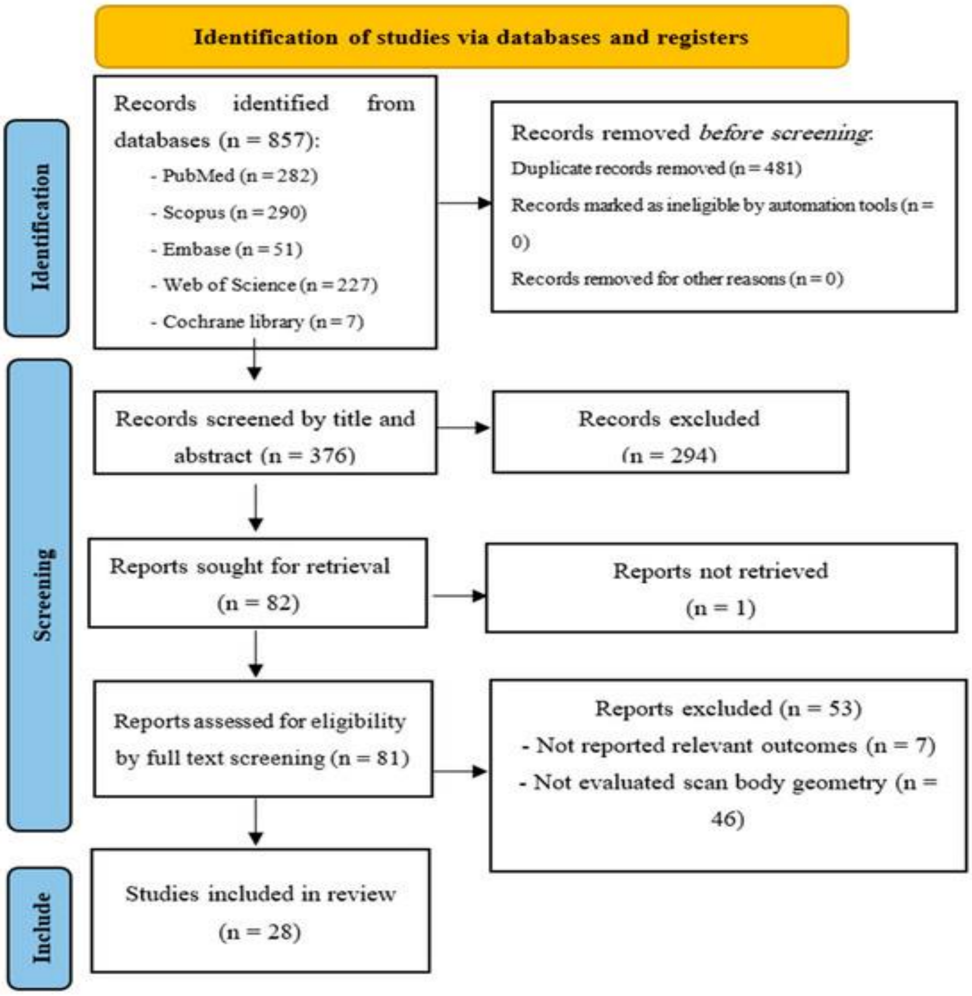

Figure 1. PRISMA flowchart outlining the study identification and selection process. No additional sources were identified via Google Scholar

Study selection and data extraction

All references were uploaded into the Rayyan web platform for systematic reviews, which enables blind dual screening [20]. Two reviewers independently assessed titles, abstracts, and full texts. Any inconsistencies were resolved through discussion or arbitration by a third researcher.

Data were extracted into a customized Excel spreadsheet, including study characteristics (title, publication year), scanner type, scan body material, implant angulation and position, dimensional parameters (height, diameter), torque values, sterilization approach, measurement protocol, and principal outcomes. The inter-reviewer reliability for data collection, assessed by Cohen's Kappa (κ = 0.86), reflected strong agreement.

Risk of bias assessment

Bias evaluation employed the QUIN (Quality Assessment Tool for In Vitro Studies of Dental Materials) [21]. This framework assesses 12 criteria, including sample size justification, operator calibration, random sequence generation, blinding, and clarity of reporting. Each domain was rated from 0 (not adequate) to 2 (adequate). The cumulative scores were converted to percentage values and categorized as high quality (>70%), moderate (50–70%), or low (<50%). Any differences in scoring were resolved through consensus or third-party consultation.

Data synthesis

A qualitative synthesis of findings was conducted because of methodological heterogeneity across studies—specifically differences in scan body forms, measurement strategies, and experimental setups—making a quantitative meta-analysis inappropriate. Instead, results were presented narratively, emphasizing comparative patterns in linear and angular trueness. Statistical indicators such as means, standard deviations, and p-values (when available) were extracted. Studies were organized according to geometric design (e.g., cylindrical, cuboidal, modified) and structural modifications (extensions, textured surfaces, etc.) to highlight performance trends among related configurations.

Ethical considerations

Since the review analyzed pre-existing published data, ethical committee approval was unnecessary. Each included investigation was verified to have received ethical authorization from the respective institutions.

Results

Study selection

The database search initially produced 857 records. After eliminating duplicates, 376 articles remained for review. Screening by title excluded 244 papers, leaving 132 for abstract evaluation. A further 50 were removed at this stage, resulting in 82 full texts being examined. One full text could not be accessed, 46 publications lacked data describing scan body geometry, and seven did not report accuracy-related outcomes. The Google Scholar search yielded no new eligible studies. Consequently, 28 articles were finalized for inclusion in this systematic review [8, 22–48] **(Figure 1)**.

Study characteristics

The included studies were published from 2020 to 2025. Out of 28 studies, 26 were in vitro and two were in vivo [27,46]. Together, they accounted for 339 total samples, with individual studies involving 4–68 participants and 1–10 implants. The best-fit alignment algorithm, often based on the iterative closest point (ICP) approach, was the most frequently employed analytical technique **(Table 1 and Table S2)**.

Table 1. Overview of included study characteristics

Citation Code	Investigation Category	Scan Component Form	Study Population Size	Analysis Approach	Number of Implants
Pan *et al.* [33]	Bench Experiment	Rectangular and curved-top designs (both from ZfxTM Intrascan matchholder H4 and ZfxTM Evolution matchholder, Zimmer Biomet, Indiana, USA)	4	Iterative point-matching technique (ICP)	Six
Motel *et al.* [25]	Bench Experiment	ELOS A/S (Gørløse, Denmark), NT-Trading GmbH (Karlsruhe, Germany), TeamZiereis (Baden-Württemberg, Germany)	10	Targeted alignment method	Three
Huang *et al.* [27]	Patient-Based	Scan component with extended rigid structure, scan component without extension	Not reported	High-precision alignment system	Two
Huang *et al.* [22]	Bench Experiment	Straumann base scan component (Basel, Switzerland), CAD/CAM scan component without extension, CAD/CAM scan component with extension	10	High-precision alignment system	Four
Revilla-León *et al.* [26]	Bench Experiment	Elos Accurate Intraoral Scan component (Elos Medtech, Gørløse, Denmark), 3D Guide Intraoral Scan component (Nt-Trading, Karlsruhe, Germany), Dynamic Abutment Intraoral scan component with connector (Talladium, Lleida, Spain)	10	Precision alignment approach	Three
Revilla-León *et al.* [28]	Bench Experiment	Elos Accurate IO scanbody Brånemark system RP (Nobel Biocare Services AG), 3D Guide K Series Scan Body (NT Digital Implant Technology)	Not reported	Not reported	Not reported
Meneghetti *et al.* [34]	Bench Experiment	SB1: 14 mm PEEK cylindrical form with trapezoidal cap, metal base (S.I.N., São Paulo, Brazil); SB2: 9 mm PEEK cylindrical form with sloped flat surface (Neodent, Curitiba, Brazil); SB3: 12 mm PEEK cylindrical form with faceted surfaces (Neodent, Curitiba, Brazil); SB4: 7 mm rounded 3D-printed grey resin prototype (Custom); SB5: 7 mm	10	Blender-based object/ICP alignment tool	Six

		three-sided flat surface 3D-printed grey resin prototype (Custom); SB6: 16 mm rod with rounded tip 3D-printed grey resin prototype (Custom); SB7: 7 mm PEEK cylindrical form with sloped flat surface (S.I.N., São Paulo, Brazil)			
Ramadan *et al.* [35]	Bench Experiment	Single-unit scan component (Elos Medtech), Two-unit Healing Abutment-Scan Peg (HA-SP; Neoss, Harrogate, HG1 2PW, United Kingdom)	10	High-precision matching system	One
Yilmaz *et al.* [30]	Bench Experiment	Standard intraoral scan component (Neoss, Woodland Hills, CA, USA), Healing abutment-scanpeg assembly (HASP)	10	Targeted alignment method	One
Lawand *et al.* [41]	Bench Experiment	CARES Mono Scanbody for screw-retained abutment (unaltered), Reduced-form scan component, Augmented-form scan component	15	Standard high-precision alignment system	Two
Alvarez *et al.* [31]	Bench Experiment	ELOS one-unit screwed-in with angled machined side (ELOS Medtech Denmark), Mozo Grau S.A pyramidal machined side screw-in and two-unit clip-in (MG), Mozo Grau S.A 12-sided screw-in one-unit (Ticare MG), Talladium machined side magnetic two-unit (Talladium Spain)	10	High-precision alignment	Six
Mizumoto *et al.* [23]	Bench Experiment	AF (IO-Flo; Dentsply Sirona, Hanau, Germany), NT (Nt-Trading GmbH & Co KG, Karlsruhe, Germany), DE (DESS-USA, Lake Mary, FL, USA), C3D (Core3Dcentres, Castle Hill, Australia), ZI (Zimmer Biomet Dental, Palm Beach Gardens, Florida, USA)	5	High-precision alignment system	Four
Jung *et al.* [32]	Bench Experiment	Basic scan abutment (IHAB 50 06 H, Dentium, Gyeonggi-do, Republic of Korea), Scanning fixture (SCJ I4565, Dentium, Gyeonggi-do, Republic of Korea)	10	Adjacent teeth landmarks for mean 3D linear intra-arch and interarch deviation analysis	Two
Moslemion *et al.* [24]	Bench Experiment	DESS 14.005, NT-Trading E9.S3D4.300, Doowon B051	10	High-precision alignment system	Four
Schmidt *et al.* [29]	Bench Experiment	3D Guide H-Series (NT Trading, Karlsruhe, Germany), Cara H10/20 (Kulzer, Hanau, Germany), H1410 (Medentika, Niefern-Öschelbronn, Germany)	10	Reference framework for precise x-, y-, z-deviation calculation	Four
Tan *et al.* [8]	Bench Experiment	Medentika L-Series Scan body Second Generation (REF L1420), Straumann CARES Mono Scan body (REF 025.4915), Core 3D Scanbody Straumann Bone level RC compatible (REF 2077), Straumann RC Scan body (REF 025.4905)	10	Zero-reference alignment technique	Ten
Li *et al.* [42]	Bench Experiment	Standard scan components (CARES Mono Scanbody; Institute Straumann AG, Basel, Switzerland), Customized scan components (Digital Wings; Segma Medical Technology, Beijing, China)	10	High-precision alignment system	Six
Zhang *et al.* [45]	Bench Experiment	Base scan components (OS), CAD/CAM scan components	10	High-precision alignment system	Four

		without extension (CS), CAD/CAM scan components with straight extension (CSS), CAD/CAM scan components with curved extension (CSA)			
Alkindi *et al.* [38]	Bench Experiment	Compact scan components (SSB), Extended scan components (LSB)	10	High-precision alignment system	Two
Park *et al.* [44]	Bench Experiment	Standard scan components without vertical anchor (nS), Experimental scan components with vertical anchor (S)	10	Coordinate measuring system (CMM: Contura; Zeiss) and software (Calypso; Zeiss) for 3D coordinates of implant platform centers and axis projection angles	Three
Pan *et al.* [48]	Bench Experiment	Nine cylinders (⌀4.8 × 4 mm, ⌀4.8 × 8 mm, ⌀4.8 × 12 mm, ⌀5.5 × 4 mm, ⌀5.5 × 8 mm, ⌀5.5 × 12 mm, ⌀6.5 × 4 mm, ⌀6.5 × 8 mm, ⌀6.5 × 12 mm), Five cuboids (3 × 6 × 8 mm, 3 × 6 × 12 mm, 4 × 6 × 6 mm, 5 × 6 × 12 mm, 5 × 6 × 8 mm), Sphere (⌀8 mm)	7	Direct measurements using a physical standard with defined coordinates, bypassing virtual alignment	Not reported
Ashry *et al.* [40]	Bench Experiment	Scan components without extensions, Scan components with extensions	20	High-precision alignment system	Four
Farah *et al.* [47]	Bench Experiment	With structural add-ons, Without structural add-ons	20 intraoral scans (10 per scanner: 5 with add-ons, 5 without)	High-precision alignment system	Four
Michelinakis *et al.* [43]	Bench Experiment	Straumann Cares Mono RN (STR), Paltop SP (PLT), MIS SP V3 (MIS), TRI TV70 scan (TRI)	10	High-precision alignment system	Four
Uzel *et al.* [37]	Bench Experiment	Group 1: Original, Group 2: 2 mm × 3 mm side slot without top alteration, Group 3: 3 mm × 4 mm side slot without top alteration, Group 4: 3 mm × 6 mm slot covering top and side surfaces	10	Precision registration software	Two
Shely *et al.* [36]	Bench Experiment	MIS ISB (asymmetrical trapezoid with sharp angles, larger surface, internal hex connection), Zirkonzhan ISB (cylindrical, no angles/asymmetry, internal hex connection)	30	High-precision alignment system	Three
Eldabe *et al.* [46]	Patient-Based	Tooth-customized scan component (TMSB), Standard scan component (CSB)	68 (2 scans per implant)	N-point and global alignment algorithms	4 (n = 1) and 5 implants (n = 6)
Anwar *et al.* [39]	Bench Experiment	Implant-level scan components (CopaSky; bredent medical, Senden, Germany) (NM), Customized scan components with circular indentations on buccal and palatal surfaces without top bevel interference (M)	10	High-precision alignment system	Four

Abbreviations: NA – not available; ICP – iterative closest point; CMM – coordinate measuring machine; SCJ – scanning jig; SB – scan body; HA-SP – healing abutment–scan peg; CSB – conventional scan body; IOS – intraoral scanner.

A diverse range of macro- and micro-geometrical scan body forms were investigated, including cylindrical, cuboidal, spherical, hybrid, and tooth-like designs. Modifications such as bar extensions, additive or subtractive surface alterations, structural protrusions, and facet or depression-type features were also explored.

Across these configurations, cylindrical designs, particularly those with a 5.5 mm diameter and 12 mm height, repeatedly showed the highest levels of linear and angular accuracy. In contrast, cuboidal and spherical shapes exhibited lower accuracy, with the spherical bodies not suitable for angular analysis.

At the micro-level, rigid or bar-style extensions consistently improved trueness by lowering both mean deviation and angular distortion. Conversely, additive surface modifications tended to worsen overall accuracy. Some faceted and concave models yielded inconsistent yet occasionally notable enhancements in scan precision. A summary of geometry-related outcomes is presented in **Table 2**.

Table 2. Relationship between scan body geometry and accuracy outcomes

Component Shape	Effect on Precision	Primary Sources
Cylindrical (varied heights/diameters)	Optimal linear and rotational precision, particularly at 5.5 mm diameter and 12 mm height	[8, 48]
Rectangular Block	Reduced precision and rotational accuracy; influenced by height and cross-sectional area	[48]
Spherical Form	Moderate precision; rotational accuracy unmeasurable due to shape	[48]
With Rigid Arm Extension	Enhanced precision and reduced rotational deviation in both lab and clinical settings	[27]
With Extended Structure	Lowered average deviation from ~119 µm to ~69 µm and rotational error from ~0.75° to ~0.36°	[22]
Reduced Modification	Improved rotational precision compared to unaltered and augmented types	[41]
Augmented Modification	Diminished surface accuracy; introduced irregularities	[41]
With Faceted Surfaces (diamond, trapezoid, etc.)	Varied effects; some enhanced precision, others negligible	[26, 34]
Hybrid Abutment-Scan Peg	Similar or slightly inferior to single-unit components	[30, 35]
Tooth-Customized Component	Significantly reduced 3D deviations and rotational errors	[46]
Indentation-Type Component	Enhanced surface precision (from ~0.282 mm to ~0.229 mm)	[39]

Scan body geometry

Overall, the data indicated that changes in geometric configuration—at both macro and micro scales—affected the linear and angular reliability of IOS-based implant impressions.

In a comparative experiment, Pan *et al.* analyzed cuboidal versus dome-shaped designs. The cuboidal type showed greater surface deviation (13.9 ± 0.7 µm) than the dome-shaped version (10.7 ± 0.2 µm), but centroid displacement and angular deviation remained statistically equivalent ($p = 0.495$, $p = 0.091$), implying that shape differences influenced surface trueness but not angular orientation [33].

Another in vitro assessment examined nine cylindrical (4.8–6.5 mm diameter, 4–12 mm height), five cuboidal (3 × 6–5 × 6 mm cross-sections, 8–12 mm height), and one spherical scan body. The 5.5 × 4 mm cylinder achieved the highest linear accuracy (4.0 ± 2.4 µm), whereas the 4 × 6 × 6 mm cuboid had the largest deviation (28.8 ± 8.6 µm). For angular accuracy, the 5.5 × 12 mm cylindrical model recorded the lowest angular error (0.013 ± 0.010°), while the 4 × 6 × 6 mm cuboid displayed the highest (0.178 ± 0.010°).

Statistical analysis confirmed significant effects of height ($p = 0.034$), diameter ($p = 0.001$), and their interaction ($p = 0.007$) on linear trueness; likewise, angular trueness was influenced by height ($p < 0.001$), diameter ($p < 0.001$), and the height-diameter interaction ($p = 0.004$) [48] **(Table 2**, **Table S2)**.

Designs incorporating structural extensions consistently showed better results. In an in vivo experiment, Huang *et al.* demonstrated that attaching a rigid bar to a flat scan body reduced mean linear deviation from 119.5 ± 83.3 µm to 68.9 ± 31.3 µm ($p = 0.008$) and angular error from 0.75 ± 0.79° to 0.36 ± 0.29° ($p = 0.049$) [27].

The corresponding in vitro experiment reported CAD/CAM scan bodies with extensions having a median trueness of 28.5 µm, compared to 35.9 µm for conventional and 38.5 µm for non-extended CAD/CAM versions ($p = 0.001$), though pairwise differences were statistically insignificant [22].

Lawand *et al.* reported that removing material from scan bodies resulted in greater angular accuracy (0.993 ± 0.062°) compared with unaltered and additively fabricated designs ($p < 0.001$), whereas added layers negatively influenced surface precision [41]. For CAD/CAM-manufactured prototypes, Zhang *et al.* found statistically significant intergroup variation ($p < 0.001$) yet no consistent advantage among straight, curved, or extension-free forms [45] **(Table 1)**.

Detailed analyses of geometric configuration and complexity highlighted strong interactions between shape type and angular deviation. In the research by Revilla-León *et al.*, three manufacturer-specific geometries—beveled, polygonal, and single-flat—displayed comparable linear deviations (4–8 μm) but varied in XZ angular discrepancies, with NT-Trading showing the most accurate results and Dynamic Abutment having the largest YZ variations [26]. A subsequent work by the same authors confirmed no linear accuracy difference between brands but noted higher XZ angular deviation in Elos compared with NT-Trading ($p < 0.001$), implying that minute angular distortions can influence clinical outcomes [28].

An in vitro comparison of four commercially available shapes showed that Ticare MG (0.050 ± 0.039 mm, 0.185 ± 0.189°) and Talladium (0.041 ± 0.024 mm, 0.221 ± 0.186°) achieved better precision than ELOS and MG ($p < 0.01$) [31] **(Table 2**, **Table S2)**. Large-scale prototype evaluations by Meneghetti *et al.* on seven PEEK and resin models revealed median 3D discrepancies ranging from 72.3 μm (SB2) to 190.3 μm (SB5) and angular errors from 0.25° to 0.89° ($p < 0.001$), confirming that subtle surface or height variations (7–16 mm) can markedly affect trueness [34]. Another investigation found ELOS (0.041 mm) and TeamZiereis (0.035 mm) to perform significantly better than NT-Trading (0.112 mm) on X and Z axes ($p < 0.01$) [25] **(Table 2**, **Table S2)**.

Hybrid and conventional approaches

When healing abutment systems were tested, the outcomes varied. Yilmaz *et al.* observed similar precision levels between conventional scan bodies and healing-abutment–scanpeg assemblies in both linear (0.014–0.043 mm vs. 0.076–0.178 mm) and angular (0.186–0.273° vs. 0.195–0.273°) assessments, validating either approach for single-implant anterior cases [30]. Conversely, Ramadan *et al.* compared one-piece Elos Medtech (0.054 ± 0.001 mm, 0.379 ± 0.023° vertical) with two-piece Neoss HA-SP (0.182 ± 0.004 mm, 1.676 ± 0.073° vertical) and found significantly smaller errors in the single-component body ($p < 0.001$) [35] **(Table 1 and 2, Table S2)**.

Investigations contrasting digital scanning and traditional or jig-assisted methods demonstrated geometric influence. Mizumoto *et al.* noted that both scan body form and impression method significantly impacted distance and angular trueness ($p < 0.05$), with Zimmer Biomet producing less deviation than Dentsply Sirona [23]. Similarly, Jung *et al.* found simple abutment scans yielded greater intra-arch linear deviation than scanning jigs ($p < 0.05$), while inter-arch discrepancies stayed below 100 μm [32]. Moslemion *et al.* reported Doowon and NT-Trading bodies showed lower linear (0.05–0.06 mm) and angular (0.35–0.52°) deviation compared to DESS (0.17 mm, 0.47°; $p < 0.001$) [24]. In a related comparison, shorter scan bodies yielded improved platform accuracy (37–52 μm) and angle precision (0.11–0.25°) than longer ones (90–128 μm; 0.31–0.57°; $p < 0.001$) [38] **(Table 1 and 2**, **Table S2)**.

Geometry and feature-specific findings

Studies investigating distinct structural traits reported diverse outcomes. Schmidt *et al.* found no meaningful variation in trueness among three body types (0.106–0.134 mm), suggesting that certain custom forms perform equivalently [29]. Tan *et al.* recorded global deformation differences between 11–42 μm ($p < 0.001$) among four brands, unaffected by torque [8]. Li *et al.* showed that modified Digital Wings produced a maximum RMS error of 37.5 μm, significantly less than Straumann's models ($p < 0.001$) [42]. Incorporating a vertical stop in traditional designs improved linear trueness at 11° conical sites (0.182 → 0.129 mm; $p < 0.05$) and reduced angular shift ($p < 0.05$), though the benefit differed by implant region [44] (**Table 1 and 2**, **Table S2**).

Research on auxiliary attachments also highlighted design impacts. Ashry *et al.* observed that accessory elements decreased overall 3D error from 0.210 ± 0.058 mm to 0.180 ± 0.039 mm ($p = 0.043$) without changing angular deviation [40]. Farah *et al.* found that additional geometric connectors in iTero and OmniCam scans halved RMS error for the OmniCam from 70.8 ± 10.3 μm to 35.2 ± 3.6 μm ($p < 0.001$) [47]. Likewise, mesh analyses revealed that simple cylindrical forms (STR, MIS) achieved better model alignment (0.019 ± 0.007 mm) than complex shapes (0.029–0.046 mm; $p < 0.05$) [43] **(Table 1 and 2, Table S2)**.

In terms of geometric modification, Uzel *et al.* demonstrated that creating proximal slots (up to 6 mm) greatly increased both linear (137 ± 41.7 μm) and angular errors (2.56 ± 1.88°), confirming that excessive structural removal undermines precision ($p < 0.05$) [37]. Shely *et al.* compared asymmetric trapezoidal and cylindrical forms under laboratory and IOS scanning, finding marked discrepancies in linear (0.020–0.135 mm vs. 0.021–0.057 mm) and angular (0.294–1.776° vs. 0.139–2.042°) results ($p < 0.0005$) [36]. Eldabe *et al.* showed that tooth-adapted bodies cut 3D deviation almost in half (61.5 ± 42.1 μm vs. 98.0 ± 56.7 μm) and angular error (0.85 ± 0.69° vs. 1.30 ± 1.06°; $p < 0.033$) [46]. Similarly, round-depression geometries enhanced surface trueness in full-arch models, reducing mean surface error from 0.282 ± 0.038 mm to 0.229 ± 0.047 mm ($p = 0.004$) [39] **(Table 1 and 2**, **Table S2)**.

Quality evaluation

Among the 28 reviewed studies, methodological ratings varied, yielding QUIN scores between 54.5% and 72.7%. Only Moslemion *et al.* met the high-quality criterion (>70%) with a 72.7% score [24], while the remaining 27 investigations were classed as moderate quality (54.5–68.2%) [8, 22–48]. Common shortcomings included insufficient sample size details, lack of operator information, unclear randomization, absence of assessor blinding, and limited outcome transparency. Conversely, categories such as clear research aims, detailed methodology, well-structured comparisons, valid accuracy assessments, appropriate statistical testing, and coherent result presentation were strongly documented **(Table S3)**.

Discussion

This review highlights that the shape and structure of scan bodies are central to determining the accuracy of digital implant impressions. Across various studies, modifications in overall geometry, dimension ratios, surface texture, and auxiliary attachments consistently influenced both linear and angular precision, regardless of the scanning protocol applied.

When macro-form was compared, cuboid configurations produced higher surface deviation than dome-like bodies, though both maintained comparable angular consistency. Likewise, polygonal and beveled configurations accurately transmitted linear spatial data but showed variation in XZ-axis angular deviation. The manufacturer's design had a measurable effect on positional fidelity, where ELOS A/S and TeamZiereis demonstrated greater 2D and 3D precision compared with NT-Trading. Among all tested morphologies, cylindrical bodies with optimized height-to-diameter proportions achieved the greatest linear and angular trueness. In hybrid healing–abutment configurations, single-unit systems performed similarly to conventional scan bodies in single-implant settings, but one-piece constructs surpassed two-component models in precision. Adjustments to the surface microstructure—including controlled subtraction, auxiliary appendages, and geometric connectors—were sometimes beneficial but, when excessive, resulted in loss of trueness. Moderate concave-type designs, however, improved accuracy in full-arch reconstructions.

Overall, the inclusion of scan bodies contributed to enhanced trueness in both linear and rotational aspects of implant digitization. Multiple studies in this review confirmed that added extensions or lateral features, such as wings or projection elements, increased measurement accuracy, likely due to better scanner recognition and landmark definition. For example, Farah *et al.* isolated data from the parallel implant group to analyze only the geometric influence, thereby avoiding angulation bias [47]. These outcomes align with general trends in literature and underline the beneficial effect of geometric reinforcement in scan body engineering [49]. Similarly, Gehrke *et al.* emphasized that positioning, material, color, manufacturing process, scanner system, and scanning approach all determine impression fidelity, especially in short-span or single-unit restorations [7]. Another systematic analysis identified factors such as implant tilt, inter-implant distance, body design, and operator proficiency as additional variables influencing scan precision [50]. Furthermore, Sanda *et al.* demonstrated that implant count, spacing, and scan body configuration affect digital impression accuracy [51]. Increasing scan length or implant separation tends to reduce measurement trueness, but this can be mitigated by geometrically reinforced scan bodies, which enhance scanner focus and spatial anchoring [51]. Collectively, these findings both support and extend prior evidence by providing targeted proof that geometric optimization of scan bodies yields practical improvements in accuracy, particularly under challenging scan spans or implant layouts.

The comparison of macro-geometries, such as cuboidal versus dome-shaped forms, revealed differences in surface deviation and centroid displacement, though angular alignment remained largely unaffected. In research directly comparing geometric profiles—like that of Moslemion *et al.*—only data from straight scan bodies were analyzed to isolate geometric variation while controlling for orientation effects [24]. The findings indicated variability in printed scan body trueness, likely associated with the printing process itself. This outcome corroborates previous evidence suggesting that surface texture and printed geometry significantly affect digital impression accuracy [52]. Distinct angular features, abrupt contours, or deep surface recesses may disrupt point-cloud generation, thus compromising scan precision [52]. Conversely, extensional structures tend to enhance accuracy by creating additional stable reference zones that assist the scanning algorithm's stitching process [22]. Studies on subtractive reconfiguration of printed bodies showed improved measurement trueness, while additively expanded structures often reduced precision due to increased surface irregularities [41]. Hence, resin-printed scan bodies, typically made through layer-by-layer additive fabrication, are more prone to shape distortion than those produced via laser sintering or subtractive milling methods.

Cylindrical scan bodies configured with precise height–diameter proportions consistently exhibited the smallest 3D and angular discrepancies among all evaluated geometric forms. Several investigations confirmed that these cylindrical types—particularly those proportioned to match implant platforms—produced the most accurate fits with minimal deviation. Data selectively drawn from Tan *et al.* focused exclusively on intraoral configurations, omitting laboratory versions to maintain uniformity in clinical applicability and scanning parameters [8]. The reduction in deviation observed in these models underscores the functional interplay between structural geometry and base compatibility. Their superior accuracy is largely attributable to the continuous curvature of cylindrical contours, which promote even light scattering and reduce artifacts such as glare and shadowing typically generated by sharp facets or angular surfaces. Simplified contours featuring fewer planes and rounded edges also demonstrated improved congruence between mesh and library data, enhancing overall scan reliability. A comprehensive meta-analysis recognized geometry as one of five key factors shaping scanning precision, though an optimal configuration was not universally identified [53]. Excessively intricate designs were shown to increase error propagation by introducing scan inconsistencies, mesh distortions, or algorithmic misalignment. Another systematic assessment classified scan body geometry among the major operator-linked sources of digital impression error—alongside factors like stitching gaps, mesh defects, and background noise—further validating the advantage of straightforward cylindrical architectures [54]. Within Revilla-Leon *et al.*, three geometries were examined; however, the dynamic abutment IOS group was excluded due to its incompatibility with coordinate measuring machine evaluation, as the authors also indicated [26].

The addition of accessory attachments and auxiliary structures to scan bodies led to measurable decreases in 3D and linear deviation values while preserving angular consistency. These supplemental components appear to stabilize the scan body and enhance recognition by the optical system without altering its spatial orientation. In the work of Farah *et al.*, data from the parallel implant subgroup were used to isolate the influence of attachment geometry, excluding potential confounding from implant angulation [47]. A related systematic analysis demonstrated that integrating auxiliary geometric aids substantially improved the accuracy of full-arch scans in edentulous cases, though the benefit of splinted assemblies remained inconsistent [49]. Likewise, Shetty *et al.* showed that linking scan bodies—through resin, floss, or custom splinting—can heighten precision during complete-arch digital workflows by maintaining reference stability, although outcomes varied according to the scanning system and procedural context [55]. Collectively, these studies emphasize how accessory integration and core design geometry interact to enhance digital accuracy.

Differences among manufacturers were also apparent. Proprietary configurations from ELOS A/S and TeamZiereis repeatedly yielded higher accuracy scores than NT-Trading, suggesting that material composition, surface microtexture, and design standardization influence scanning results. Motel *et al.* tested both one-step and two-step capture protocols; however, only results from the single-step procedure were retained here to ensure methodological uniformity with other datasets [25]. This alignment enabled direct comparison across manufacturers and underscored the importance of unified design validation during commercial production. In contrast, substantial geometric alterations, such as extended proximal slots or bulky additive modifications, negatively impacted both linear and angular metrics. Such overextension may interrupt scanning continuity, create noise artifacts, or obscure reference boundaries. For evaluating angulation-specific effects in Moslemion *et al.*, only measurements from the Doowon series were retained because their design closely resembled typical clinical forms, preserving external validity [24].

From a clinical perspective, practitioners are encouraged to employ scan bodies that incorporate structural extensions, dimensionally optimized cylindrical geometries, or flat-sided profiles—including bar-extended or facet-minimized forms—to improve both linear and rotational precision in daily digital workflows [27, 34]. At the same time, manufacturers are urged to implement standardized validation criteria outlining minimal geometric benchmarks and accuracy thresholds under intraoral conditions to promote cross-system consistency [23, 25]. Future research should adopt harmonized testing methodologies, expand to multi-operator in vivo trials, and assess the cost–benefit implications of complex versus simplified geometries, guiding evidence-based refinement of digital implant practices.

Certain limitations must be acknowledged. Although growing data emphasize geometric impact, much of the current evidence arises from in vitro or animal experiments, which fail to reproduce clinical realities like saliva presence, soft-tissue behavior, or patient motion. Only two in vivo investigations were available, restricting generalization. Substantial heterogeneity across scanning approaches, measurement systems, and reporting standards prevented meta-analytical synthesis. Operator skill variation, implant positioning, and scanner settings were inconsistently documented, adding further confounding potential. Moreover, the underlying optical–geometric mechanisms—including light reflection differences between curved and angular surfaces—remain insufficiently characterized. Finally, none of the included studies evaluated patient-oriented variables such as prosthetic fit, insertion torque, or clinical comfort, limiting insight into real-world applicability and user experience.

Challenges and future directions

Although notable progress has been made in optimizing scan body designs, several unresolved issues hinder the translation of laboratory findings to clinical environments. First, the dominance of in vitro and animal-based investigations limits insight into real-world performance, where variables such as saliva presence, tissue flexibility, and patient motion play crucial roles. Subsequent studies should therefore emphasize standardized in vivo trials using harmonized scanning methods, implant placements, and evaluation metrics. Second, discrepancies in scanner hardware, measuring approaches, and classification of geometries complicate comparative analyses and restrict the feasibility of meta-analyses; thus, unified standards for terminology and data reporting are required. Third, the interaction between optical behavior and shape configuration—for example, the way light disperses over smooth versus angular contours—remains insufficiently explored; focused research on these mechanisms could guide the scientific design of future scan bodies. Fourth, inconsistencies in operator skill and scanner setup act as possible confounders; implementing semi-automated or guided scan procedures may help minimize such errors. Finally, there is a marked shortage of patient-focused indicators—including insertion torque, prosthetic accuracy, and overall procedural efficiency—which should be incorporated into future studies to better demonstrate clinical value.

By addressing these challenges through coordinated, multidisciplinary research and robust in vivo verification, the field can progress toward clinically validated scan body designs that enhance both precision and workflow reliability. Although this review outlines several geometry-related determinants of digital impression accuracy, clinical interpretation remains limited because most evidence originates from in vitro or preclinical data. Therefore, conclusions should be viewed cautiously until confirmed under real-world conditions, accounting for intraoral factors like moisture, movement, and soft tissue variation. Additionally, the influence of differing intraoral scanner (IOS) models on measurement precision is still poorly understood. Variations in hardware optics, software calibration, and algorithmic processing between devices can yield scanner-dependent discrepancies in trueness and repeatability. Future research should involve direct comparisons among multiple IOS platforms, employing consistent geometries and identical scanning environments to clarify how device type impacts scan body outcomes.

Conclusions

The geometry of the scan body plays a decisive role in determining implant impression fidelity. Rigid extensions—such as connecting bars or lateral wings—consistently enhance both linear and angular precision. Large-scale geometric shapes also affect surface accuracy, where rectangular designs tend to introduce greater deviation than rounded or dome-like configurations. Among overall forms, streamlined cylindrical shapes demonstrate higher accuracy than more intricate cuboidal or spherical counterparts. Hybrid healing abutments exhibit performance comparable to conventional scan bodies in single-unit applications, while monolithic configurations outperform multi-component designs. Simplified geometries and targeted refinements aid in better mesh alignment, whereas overly complex modifications negatively impact precision by producing irregularities or data noise. On the microstructural level, carefully designed extensions and surface patterns can enhance digital alignment, but excessive additions often distort the scanning process.

From a clinical standpoint, these findings support the use of simple, clearly defined reference shapes that include functional micro-features, ensuring optimal trueness and reproducibility. Future investigations should employ standardized in vivo testing frameworks, incorporate patient-centered criteria (such as fit and procedural comfort), and explore the optical–geometric interactions that shape scanner performance. Advancing along these lines will lead to data-driven improvements in scan body technology and elevate the quality of digital implant dentistry.

Abbreviations

The following abbreviations are used in this manuscript:

IOSs	Intraoral scanners

PICO	Population, intervention, comparison, outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
MeSH	Medical Subject Headings
CAD/CAM	Computer-aided design/computer-aided manufacturing
QUIN	Quality Assessment Tool For In Vitro Studies
PEEK	Polyether ether ketone
RMS	Root mean square

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References

1. Alikhasi M, Alsharbaty MHM, Moharrami M. Digital implant impression technique accuracy: a systematic review. Implant Dent. 2017;26:929-35.
2. Lee H, So JS, Hochstedler JL, Ercoli C. The accuracy of implant impressions: a systematic review. J Prosthet Dent. 2008;100:285-91.
3. Marques S, Ribeiro P, Falcão C, Lemos BF, Ríos-Carrasco B, Ríos-Santos JV, et al. Digital impressions in implant dentistry: a literature review. Int J Environ Res Public Health. 2021;18:1020.
4. Papaspyridakos P, Vazouras K, Chen YW, Kotina E, Natto Z, Kang K, et al. Digital vs conventional implant impressions: a systematic review and meta-analysis. J Prosthodont. 2020;29:660-78.
5. Rutkunas V, Gedrimiene A, Adaskevicius R, Al-Haj Husain N, Özcan M. Comparison of the clinical accuracy of digital and conventional dental implant impressions. Eur J Prosthodont Restor Dent. 2020;28:173-81.
6. Schmidt A, Schlenz MA, Liu H, Kämpe HS, Wöstmann B. The influence of hard- and software improvement of intraoral scanners on the implant transfer accuracy from 2012 to 2021: an in vitro study. Appl Sci. 2021;11:7166.
7. Gehrke P, Rashidpour M, Sader R, Weigl P. A systematic review of factors impacting intraoral scanning accuracy in implant dentistry with emphasis on scan bodies. Int J Implant Dent. 2024;10:20.
8. Tan JZH, Tan MY, See Toh YL, Wong KY, Tan KBC. Three-dimensional positional accuracy of intraoral and laboratory implant scan bodies. J Prosthet Dent. 2022;128:735-44.
9. Mizumoto RM, Yilmaz B. Intraoral scan bodies in implant dentistry: a systematic review. J Prosthet Dent. 2018;120:343-52.
10. Eggmann F, Blatz MB. Recent advances in intraoral scanners. J Dent Res. 2024;103:1349-57.
11. Arcuri L, Pozzi A, Lio F, Rompen E, Zechner W, Nardi A. Influence of implant scanbody material, position and operator on the accuracy of digital impression for complete-arch: a randomized in vitro trial. J Prosthodont Res. 2020;64:128-36.
12. Gómez-Polo M, Álvarez F, Ortega R, Gómez-Polo C, Barmak AB, Kois JC, et al. Influence of the implant scan body bevel location, implant angulation and position on intraoral scanning accuracy: an in vitro study. J Dent. 2022;121:104122.
13. Ender A, Mehl A. Accuracy of complete-arch dental impressions: a new method of measuring trueness and precision. J Prosthet Dent. 2013;109:121-8.
14. Flügge T, van der Meer WJ, Gonzalez BG, Vach K, Wismeijer D, Wang P. The accuracy of different dental impression techniques for implant-supported dental prostheses: a systematic review and meta-analysis. Clin Oral Implant Res. 2018;29(Suppl S16):374-92.
15. Schmidt A, Wöstmann B, Schlenz MA. Accuracy of digital implant impressions in clinical studies: a systematic review. Clin Oral Implant Res. 2022;33:573-85.
16. Ma J, Zhang B, Song H, Wu D, Song T. Accuracy of digital implant impressions obtained using intraoral scanners: a systematic review and meta-analysis of in vivo studies. Int J Implant Dent. 2023;9:48.
17. Albanchez-González MI, Brinkmann JC, Peláez-Rico J, López-Suárez C, Rodríguez-Alonso V, Suárez-García MJ, et al. Accuracy of digital dental implants impression taking with intraoral scanners compared with conventional impression techniques: a systematic review of in vitro studies. Int J Environ Res Public Health. 2022;19:2026.
18. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg. 2021;88:105906.
19. Haddaway NR, Collins AM, Coughlin D, Kirk S. The role of Google Scholar in evidence reviews

and its applicability to grey literature searching. PLoS One. 2015;10:e0138237.

20. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016;5:210.
21. Sheth VH, Shah NP, Jain R, Bhanushali N, Bhatnagar V. Development and validation of a risk-of-bias tool for assessing in vitro studies conducted in dentistry: the QUIN. J Prosthet Dent. 2024;131:1038-42.
22. Huang R, Liu Y, Huang B, Zhang C, Chen Z, Li Z. Improved scanning accuracy with newly designed scan bodies: an in vitro study comparing digital versus conventional impression techniques for complete-arch implant rehabilitation. Clin Oral Implant Res. 2020;31:625-33.
23. Mizumoto RM, Yilmaz B, McGlumphy EA Jr, Seidt J, Johnston WM. Accuracy of different digital scanning techniques and scan bodies for complete-arch implant-supported prostheses. J Prosthet Dent. 2020;123:96-104.
24. Moslemion M, Payaminia L, Jalali H, Alikhasi M. Do type and shape of scan bodies affect accuracy and time of digital implant impressions? Eur J Prosthodont Restor Dent. 2020;28:18-27.
25. Motel C, Kirchner E, Adler W, Wichmann M, Matta RE. Impact of different scan bodies and scan strategies on the accuracy of digital implant impressions assessed with an intraoral scanner: an in vitro study. J Prosthodont. 2020;29:309-14.
26. Revilla-León M, Fogarty R, Barrington JJ, Zandinejad A, Özcan M. Influence of scan body design and digital implant analogs on implant replica position in additively manufactured casts. J Prosthet Dent. 2020;124:202-10.
27. Huang R, Liu Y, Huang B, Zhou F, Chen Z, Li Z. Improved accuracy of digital implant impressions with newly designed scan bodies: an in vivo evaluation in beagle dogs. BMC Oral Health. 2021;21:623.
28. Revilla-León M, Smith Z, Methani MM, Zandinejad A, Özcan M. Influence of scan body design on accuracy of the implant position as transferred to a virtual definitive implant cast. J Prosthet Dent. 2021;125:918-23.
29. Schmidt A, Dent DM, Billig JW, Schlenz MA, Wöstmann B, Dent M. The influence of using different types of scan bodies on the transfer accuracy of implant position: an in vitro study. Int J Prosthodont. 2021;34:254-60.
30. Yilmaz B, Gouveia D, Marques VR, Diker E, Schimmel M, Abou-Ayash S. The accuracy of single implant scans with a healing abutment-scanpeg system compared with the scans of a scanbody and conventional impressions: an in vitro study. J Dent. 2021;110:103684.
31. Alvarez C, Domínguez P, Jiménez-Castellanos E, Arroyo G, Orozco A. How the geometry of the scan body affects the accuracy of digital impressions in implant supported prosthesis. In vitro study. J Clin Exp Dent. 2022;14:e1008-14.
32. Jung HT, Kim HY, Song SY, Park JH, Lee JY. Accuracy of implant impression techniques with a scannable healing abutment. J Prosthet Dent. 2022;128:729-34.
33. Pan Y, Tsoi JKH, Lam WYH, Chen Z, Pow EHN. Does the geometry of scan bodies affect the alignment accuracy of computer-aided design in implant digital workflow: an in vitro study? Clin Oral Implant Res. 2022;33:313-21.
34. Meneghetti PC, Li J, Borella PS, Mendonça G, Burnett LH Jr. Influence of scanbody design and intraoral scanner on the trueness of complete arch implant digital impressions: an in vitro study. PLoS One. 2023;18:e0295790.
35. Ramadan RE, Razek MKA, Mohamed FS, Fahmy RA, Abd-Ellah ME. Positional transfer accuracy of titanium base implant abutment provided by two different scan body designs: an in vitro study. BMC Oral Health. 2023;23:746.
36. Shely A, Lugassy D, Rosner O, Zanziper E, Nissan J, Rachmiel S, et al. The influence of laboratory scanner versus intra-oral scanner on determining axes and distances between three implants in a straight line by using two different intraoral scan bodies: a pilot in vitro study. J Clin Med. 2023;12:6644.
37. Uzel SM, Guncu MB, Aktas G, Arikan H, Reiss N, Turkyilmaz I. Influence of the implant scan body modifications on trueness of digital impressions. J Dent Sci. 2023;18:1771-77.
38. Alkindi S, Hamdoon Z, Aziz AM. Effect of different impression coping and scan body designs on the accuracy of conventional versus digital implant impressions: an in vitro study. J Dent. 2024;146:105045.
39. Anwar H, Azer A, AboElHassan RG. Influence of a specially designed geometric device and modified scan bodies on the accuracy of a maxillary complete arch digital implant scan: an in vitro study. J Prosthet Dent. 2024;131:683.e1-7.
40. Ashry A, Abdelhamid AM, Ezzelarab S, Khamis MM. Effect of using scan body accessories and inter-implant distances on the accuracy of complete arch implant digital impressions: an in vitro study. J Prosthodont. 2024;1-9.

41. Lawand G, Ismail Y, Revilla-León M, Tohme H. Effect of implant scan body geometric modifications on the trueness and scanning time of complete arch intraoral implant digital scans: an in vitro study. J Prosthet Dent. 2024;131:1189-97.
42. Li Y, Fang H, Yan Y, Geng W. Accuracy of intraoral scanning using modified scan bodies for complete arch implant-supported fixed prostheses. J Prosthet Dent. 2024;132:994.e1-8.
43. Michelinakis G, Apostolakis D, Nikolidakis D, Lapsanis G. Influence of different scan body design features and intraoral scanners on the congruence between scan body meshes and library files: an in vitro study. J Prosthet Dent. 2024;132:454.e1-11.
44. Park GS, Chang J, Pyo SW, Kim S. Effect of scan body designs and internal conical angles on the 3-dimensional accuracy of implant digital scans. J Prosthet Dent. 2024;132:190.e1-7.
45. Zhang T, Yang B, Ge R, Zhang C, Zhang H, Wang Y. Effect of a novel ‘scan body’ on the in vitro scanning accuracy of full-arch implant impressions. Int Dent J. 2024;74:847-54.
46. Eldabe AK, Adel-Khattab D, Botros KH. Trueness of tooth modified scan bodies as a novel technique for edentulous full arch implant supported dental prosthesis: an in vivo prospective comparative study. BMC Oral Health. 2025;25:29.
47. Farah RI, Alresheedi B, Alazmi S, Al-Haj Ali SN. Evaluating the impact of scan body angulation and geometric attachments on the accuracy of complete-arch digital implant impressions: a comparison of two intraoral scanners. J Prosthodont. 2025;34:174-81.
48. Pan Y, Dai X, Tsoi JK, Lam WY, Pow EH. Effect of shape and size of implant scan body on scanning accuracy: an in vitro study. J Dent. 2025;152:105498.
49. Wan Q, Limpuangthip N, Hlaing NHMM, Hahn S, Lee JH, Lee SJ. Enhancing scanning accuracy of digital implant scans: a systematic review on application methods of scan bodies. J Prosthet Dent. 2024;132:898.e1-9.
50. Rutkūnas V, Gečiauskaitė A, Jegelevičius D, Vaitiekūnas M. Accuracy of digital implant impressions with intraoral scanners: a systematic review. Eur J Oral Implant. 2017;10(Suppl S1):101-20.
51. Sanda M, Miyoshi K, Baba K. Trueness and precision of digital implant impressions by intraoral scanners: a literature review. Int J Implant Dent. 2021;7:97.
52. Pachiou A, Zervou E, Tsirogiannis P, Sykaras N, Tortopidis D, Kourtis S. Characteristics of intraoral scan bodies and their influence on impression accuracy: a systematic review. J Esthet Restor Dent. 2023;35:1205-17.
53. Gómez-Polo M, Donmez MB, Çakmak G, Yilmaz B, Revilla-León M. Influence of implant scan body design (height, diameter, geometry, material, and retention system) on intraoral scanning accuracy: a systematic review. J Prosthodont. 2023;32:165-80.
54. Revilla-León M, Aragoneses R, Arroyo Valverde EM, Gómez-Polo M, Kois JC. Classification of scanning errors of digital scans recorded by using intraoral scanners. J Esthet Restor Dent. 2025;37:1363-71.
55. Shetty PS, Gangurde AP, Chauhan MR, Jaiswal NV, Salian PR, Singh V. Accuracy of the digital implant impression with splinted and non-splinted intraoral scan bodies: a systematic review. J Indian Prosthodont Soc. 2025;25:3-12.